OCEAN MINERALS FORWARD »

Processing Is Power

From the Seafloor to the Factory Floor

Finding critical minerals is only the beginning.

Nickel, copper, cobalt, manganese, and other minerals do not move directly from a mine or the seafloor into a battery, data center, aircraft, electrical grid, or manufacturing plant. They must first be processed, separated, refined, and transformed into materials manufacturers can use.

That makes processing one of the most important links in the critical-mineral supply chain — and one of the biggest opportunities for the United States and its allies.

THE MIDDLE OF THE SUPPLY CHAIN MATTERS

Critical-mineral discussions often focus on where resources are located. But extracting a resource does not automatically create a usable supply of minerals.

Processing is where raw mineral feedstocks begin becoming industrial products. Refining and separation produce the individual metals and materials needed by manufacturers. Those steps require specialized facilities, technical expertise, infrastructure, investment, energy, and reliable access to feedstock.

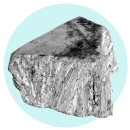
If those capabilities are concentrated elsewhere, even domestically produced resources can remain dependent on foreign supply chains. **You don't have mineral security if someone else controls the processing.**

One Resource Can Produce Multiple Metals

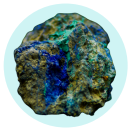
Polymetallic nodules are different from many conventional mineral deposits because they contain several economically important metals within a single resource.



COPPER



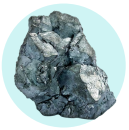
NICKEL



COBALT



MANGANESE



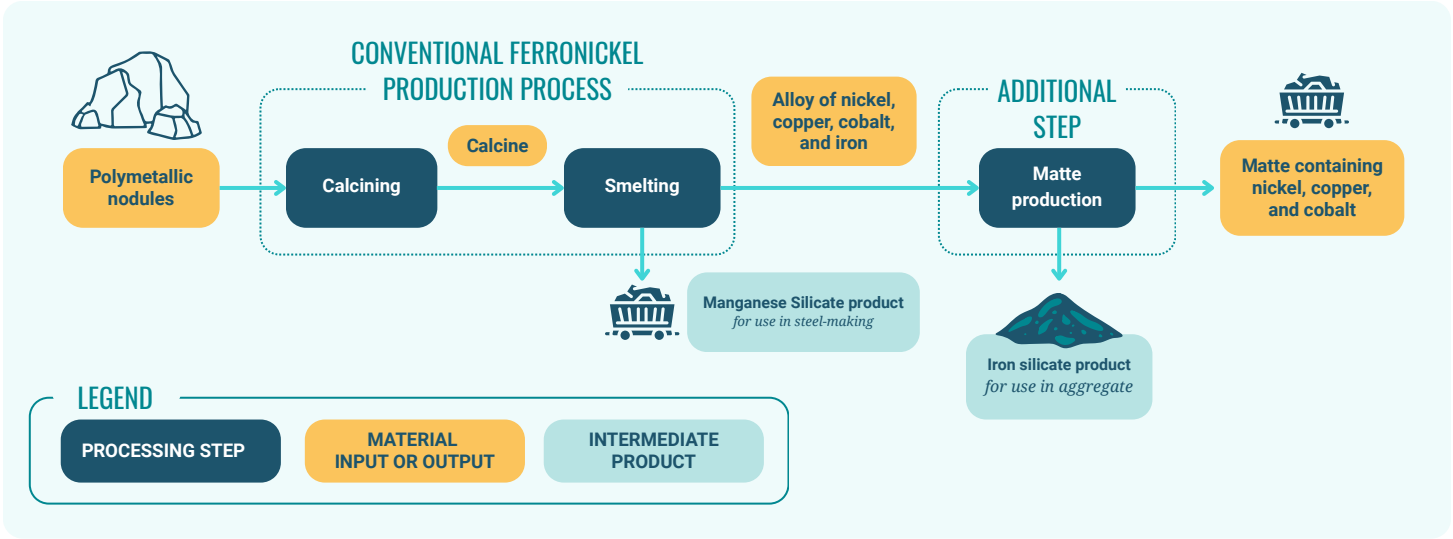
RARE EARTHS

The Metallurgy Is Not Starting From Zero

Polymetallic nodules are a novel feedstock, but many of the metallurgical processes that can be used to treat them build on technologies already used in the global mining and metals industry.

That matters because developing a nodule supply chain does not necessarily mean inventing an entirely new processing industry from scratch. Existing **pyrometallurgical and hydrometallurgical processes can be adapted and integrated** to separate and recover the metals contained in nodules.

The challenge is optimizing those processes for a different feedstock — maximizing recovery, managing energy and material inputs, and producing products that can enter existing industrial supply chains. (See chart next page)



It Has Already Been Demonstrated Through Existing Infrastructure

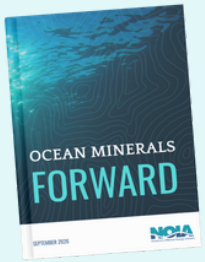
One of the most important questions surrounding ocean minerals is whether nodules can be processed through real industrial equipment rather than only under laboratory conditions.

Recent work in Japan provides an important example. The Metals Company and Japan's Pacific Metals Co. processed polymetallic nodules using an existing commercial-scale ferronickel production line. The demonstration produced a **nickel-copper-cobalt alloy** along with a **manganese-rich silicate product,** showing how existing metallurgical infrastructure can potentially be adapted to a new ocean-mineral feedstock.

Processing Creates Value on Shore

The economic opportunity associated with ocean minerals does not end when a vessel returns to port. Processing connects offshore resource development with a much larger onshore industrial ecosystem: **ports, logistics, construction, engineering, processing and refining facilities, equipment suppliers, manufacturers, research institutions, and skilled workers.**

That means decisions about where processing occurs can influence where much of the downstream economic activity occurs as well.



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